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## RHYTHMS AND ENDOMIXIS IN VARIOUS RACES OF PARAMÆCIUM AURELIA.

LORANDE LOSS WOODRUFF,

OSBORN ZOÖLOGICAL LABORATORY, YALE UNIVERSITY.

In view of the fact that the study of rhythms and endomixis in *Paramæcium* was made chiefly on my long pedigreed race of *Paramæcium aurelia*, it has been suggested by a couple of authors that the reorganization process may be something peculiar to this race, perhaps resulting from long subjection to conditions which preclude the possibility of conjugation. This assumption, however, was rendered exceedingly improbable from the data presented by Woodruff and Erdmann<sup>1</sup> in their original complete paper which showed that "the same reorganization process was resumed in all the lines within a relatively short time after conjugation" was allowed to occur in a subculture of the main race, and also that the phenomenon was observed early in the culture of a race which was secured by Erdmann from Berlin, Germany. Further, Erdmann and Woodruff<sup>2</sup> in a paper on endomixis in *Paramæcium caudatum* stated incidentally that endomixis had been found in two new races of *Paramæcium aurelia* immediately upon their isolation.

The above data more than justify the early conclusion of Woodruff and Erdmann that "this reorganization process is a normal phenomenon and *probably occurs in all races of the species Paramæcium aurelia*,"<sup>3</sup> but in connection with other work on *Paramæcium* it has been necessary to employ various races for study and the purpose of the present paper is to record briefly the additional data bearing on the points under discussion. This may be most readily accomplished by considering seratim the graphs of the life histories which show the rhythms and the occurrence of endomixis in the respective cultures. Since

<sup>1</sup> *Journal of Experimental Zoology*, Vol. 17, No. 4, 1914.

<sup>2</sup> *Journal of Experimental Zoology*, Vol. 20, No. 2, 1916.

<sup>3</sup> *Ibid.*, 1914, p. 474.

the methods of conducting the cultures, plotting the graphs, etc., has been fully described in earlier papers from this laboratory, the reader is referred to them for details of technique. It is only necessary to emphasize here that the occurrence of endo-

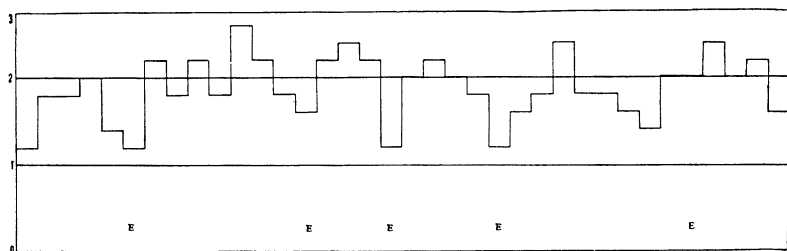


FIG. 1.

mixis has been determined, of course, in each case by the cytological study of animals preserved almost daily from each culture during the periods under discussion.

*Race I.* (*Woodruff's Main Culture.*)—Isolated May 1, 1907, at Williamstown, Mass., and carried in pedigreed culture to

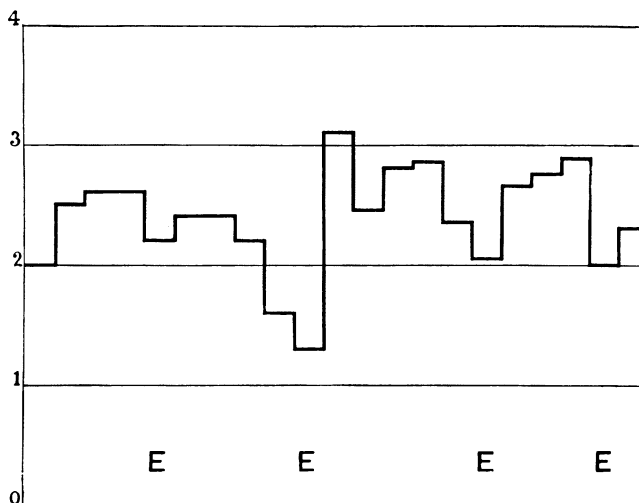


FIG. 2.

date (July, 1917). During this period of more than ten years it has attained over 6,000 generations without conjugation. The discovery of endomixis was made on this race and full details

have been presented in earlier papers. Fig. 1<sup>1</sup> gives a typical graph of a subculture showing the relation of rhythms and endomixis.

*Race II. (Berlin Race.)*—Isolated by Erdmann in Berlin. For details see Woodruff and Erdmann, 1914.

*Race III. (Oberlin Race.)*—The initial animals of this pedigreed culture was supplied by Professor R. A. Budington, of Oberlin, Ohio. The culture was started October 8, 1914, and was discontinued after nearly two years during which time over 1,000 generations were obtained. Fig. 2 is a graph of the average division rate of the four lines of this culture again averaged for each of the first 21 five-day periods of its life when it was being intensively studied with reference to the occurrence of rhythms and endomixis. The graph shows four rhythms and at the low point between each endomixis occurred. It is to be

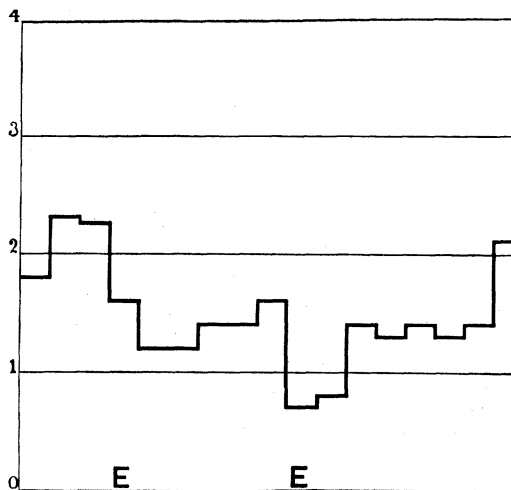


FIG. 3.

noted that the reorganization process appeared during the fifth five-day period after the isolation of the culture, thus showing once more that this phenomenon is not dependent upon long subjection to culture conditions for its genesis. The length of the rhythmic periods for this race is also essentially the same as in Race I (cf. Fig. 1).

*Race IV. (Bryn Mawr Race.)*—The animal which started

<sup>1</sup> *Ibid.*, 1914, Fig. 17.

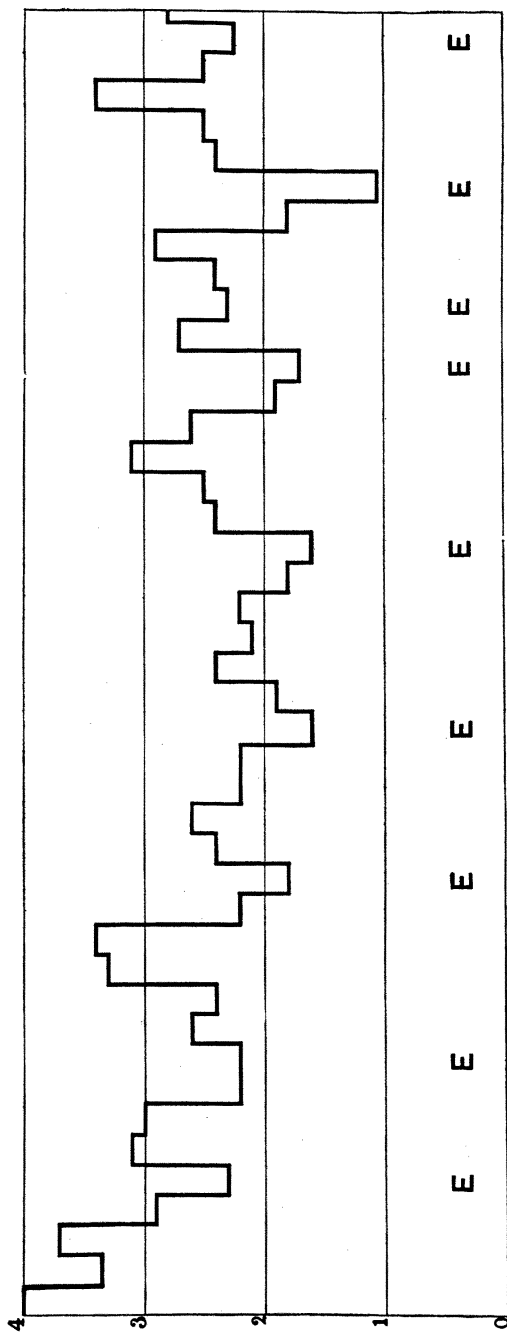


FIG. 4.

this pedigreed culture was isolated on January 7, 1915, from material supplied by Dr. Florence Peebles from Bryn Mawr, Pa. The culture was discontinued at the 650th generation on February 8, 1916. Fig. 3 shows the relationship of rhythms and endomixis during the first eighty-five days of the culture when the animals were being examined for the reorganization process. The results fully substantiate those obtained from previous races. The last inter-rhythm period shown in the diagram is apparently longer than usual—though it is possible that endomixis was overlooked about the 15th five-day period.

*Race V. (Oxford Race.)*—Culture started, from material secured at Oxford, Ohio, on July 16, 1915, and discontinued on August 7, 1916, at the 1,000th generation. The division rate of the culture is shown in Fig. 4 for the first 44 five-day periods of

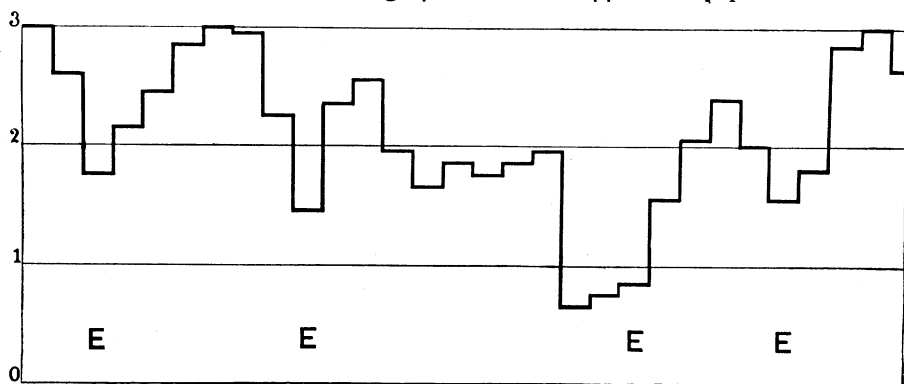


FIG. 5.

its life. During this time nine rhythms occurred at each of which endomixis was observed. It is hoped that readers who may possess doubts concerning rhythms and endomixis will carefully consider this graph.

*Race VI. (Woods Hole Race.)*—This race was obtained by Dr. G. A. Baitsell at Woods Hole, Mass., and its pedigreed culture was begun on August 11, 1915, and discontinued on January 14, 1916, at the 305th generation. Fig. 5 gives the graph of the division rate of this culture throughout its existence.<sup>1</sup>

<sup>1</sup> The division rate is plotted consistently one quarter of a division per day too fast for every five-day period, owing to a draughtsman's error. An E should be inserted in the first period.

Endomixis occurred as soon as the culture was started and recurred at the usual intervals. The animal was not studied cytologically during the 14th five-day period so that endomixis is not indicated by an *E* in this period on the chart, but from the character of the curve there can be little doubt that an examination of stained specimens would have revealed it.

In a word, then, the data from every culture of *Paramæcium aurelia* (isolated from as diverse localities as Ohio and Germany) which we have studied prove beyond doubt, I believe, that endomixis is a normal periodic phenomenon which occurs in all races of *Paramæcium aurelia*.